

on the west of this line practice circumcision, but in the country to the eastward of the line the custom is not in force. The line in yellow, from C to D, and continued on along the blue line to B, demarks the eastern limit of splitting the urethra—a genital mutilation having a very wide geographic range over the central and western portions of the Australian continent. The other blue line, from E to F, determines the western boundary of the tribes who practice splitting the urethra and circumcision, neither of these customs being found between that line and the coast of Western Australia. From the point F, along the coastal district to Roebourne and Condon, the rites referred to are not now insisted upon, and it is doubtful if their adoption by the natives there was ever universal.

ON THE OSTEOLOGY OF THE WOODPECKERS.

BY DR. R. W. SHUFELDT.

(Plate IX.)

(Read October 5, 1900.)

INTRODUCTION.

During the past ten years I have been collecting osteological material with the view of making a comparative study of the skeletons of the *Pici*, or suborder of Woodpeckers. In time this material became so extensive that I found I had all of the genera of the North American fauna represented, and had the opportunity of examining into the osteology of many other species from different parts of the world. Being advantageously situated with respect to the large libraries in America, I read and investigated everything that came to my notice upon this subject, and wrote out notes upon the same. Occasionally I printed a brief account of some of the osteological points of interest in this group as they came to hand, but the main bulk of my labors in this direction have long remained unpublished. True it is that in the *Proceedings of the Zoölogical Society of London* I printed finally (February 3, 1891) a short account of the osteological characters of the *Pici*, with a few brief notes upon the group, but this was nothing more than a partial abstract based upon what had been

accomplished up to that time. Since then all of my descriptions of the skeletology of the Woodpeckers have been gathered together, and I am inclined to believe they form the most complete history of the skeleton in those birds, both in detail and in a comparative way, that has thus far been furnished by anatomists. For making a fair and accurate copy of my collected descriptions and account of the osteology of this important group I am wholly indebted to the kind patience and intelligence of my wife, Alfhild, and it gives me great pleasure to thank her here for the assistance she has rendered.

The plates and figures illustrating the present contribution have never heretofore been published, and it is hoped that comparative anatomists will find them useful in their work.

At least three good families of Woodpeckers are known to science—that is, the *Picidæ*, the *Picumnidæ* and the *Iyngidæ*—but of these only the first-mentioned, with a variety of its genera and numerous species, is represented in the avifauna of the United States. Naturalists need not be reminded here by name of all of these forms, as the majority of them are familiar to every one. Every genus is represented by a more or less perfect skeleton in the material I have before me at the present writing, and upon which this account will be based; some skeletons I have in large series, as *Melanerpes torquatus*, of which bird I collected a large number in northwestern New Mexico in 1885. Some I have in the young stages, beautifully exhibiting the development of the skull and trunk-skeleton; others, again, are more imperfect. Thanks to the United States National Museum, I have at hand the skeleton of an Ivory-billed Woodpecker, but it unfortunately lacks the skull and some few other bones. The same institution, however, has kindly loaned me a very fair skull of *Campephilus imperialis*. Numerous skeletons of various species of the genus *Dryobates*, of my own preparation, are available, and I am indebted to Mr. Samuel Parker, of Fort Klamath, Ore., for a fine skeleton of *Xenopicus aibolarvatus*. Further, I must not forget to thank my friend Mr. Thomas McIlraith, of Hamilton, Ont., Canada, for a fine skeleton of a male *Picoides arcticus*. I have skeletons in force of every one of our species of *Sphyrapicus*, all of my own collecting and preparation, and by purchase I have obtained excellent skeletons of *Ceophlæus pileatus*. Dr. W. S. Strode, of Bernadotte, Ill., has

kindly forwarded me skeletons of *Melanerpes erythrocephalus* and *M. carolinus*, and Herbert Brown, Esq., the well-known naturalist of Tucson, Ariz., has, among numerous similar favors, kindly given me the skeletons of a male and of a female *Melanerpes uropygialis*. Of the genus *Colaptes* I have a large assortment, from quarters too numerous to mention on this page. Mr. G. Freaan Morcom, of Chicago, and Mr. F. Stephens have presented me with alcoholic specimens of *Dryobates scalaris lucasanus*, from Lower California.

I command few or no foreign forms, but, in addition to much other literature upon them, I have a personal copy of Prof. W. K. Parker's memoir "On the Morphology of the Skull in the Woodpeckers and Wrynecks" (1874).

With respect to the *Picidae*, authoritative writers and ornithologists of all times seem to be of one opinion—that that family, taken in connection with the two others mentioned above, constitute a very distinct and natural group of birds with very evident passerine affinities. The American Ornithological Union considers this group to equal an order, the *Pici*; while here I treat them as one of my suborders, which likewise is designated by the same name.

Both Sundevall and Kessler recognized a separate group for the Woodpeckers (*Pici*), while Huxley's well-known characterization of them as his group, the *Celeomorpha*, is now too well comprehended to render it necessary for me to reproduce it here (*P. Z. S.*, 1867, p. 467). At the time that that distinguished authority promulgated the opinion to which we allude he believed that the vomers in the skulls of some species of Woodpeckers remained distinct throughout life; and, further, saw the nearest affines of these birds in the Passeres (or his *Coracomorpha*).

In the memoir of his, to which I have just alluded in a former paragraph, Prof. W. K. Parker wrote it as his opinion, in referring to the Woodpeckers as a group, that "The fact is they are like early embryos of the Passerinae, in their palatal region arrested at a most simple Lacertian stage, whilst in other respects they are metamorphosed and specialized beyond any other kind of birds. As far as their upper face is concerned, their arrested 'maxillo-palatines,' symmetrical 'vomers,' 'septo-maxillaries' and feebly developed turbinal scrolls entitle them to a name which shall be a memorial of their Lacertian facial morphology. I therefore propose to call them the '*Saurognothæ*.'"

Garrod saw the vomer of *Gecinus viridis* in the bone which Parker designates as his "medio-palatine," and of the "vomers" of Parker, Garrod has said that "they look much more like the inner edges of the imperfectly ossified palatines." Both opinions are candid, and simply point to a difference of opinion in a matter of identity.¹

Still another view: the distinguished ornithotomist Max Fürbringer divides his order *Coracornithes* into three suborders, of which the first is the *Pico-Passeriformes*; and these latter are again divided into three groups, the first of which is the *Pico-Passeres*. Now he subdivides the *Pico-Passeres* into the *Pici* and *Passeres*, and makes the *Pici* include four families, viz., the *Capitonidæ*, the *Rhamphastidæ*, the *Indicatoridæ* and the *Picidæ*.² The *Picidæ* here include the two subfamilies, the *Iynginæ* and the *Picinæ*. With this brief recapitulation of the opinions of former writers, I will now proceed to examine the extensive North American material before me, describe what I find in due order, and, as usual, present what it seems to indicate to me.

OF THE SKULL AND ASSOCIATED BONES IN THE PICIDÆ.

As an introduction to this part of the skeleton, I select a series of skulls taken from adult and nestling specimens of *Colaptes mexicanus*. These are very perfect and have the hyoid arches and other bones of the sense organs associated with them.

In *Colaptes* the premaxillary, slightly decurved throughout, is broad at the base and gradually tapers to its apex. It is composed of dense bone, but apparently not much more so than are the other bones of the face. On the proximal moiety of the culmen, the median suture is persistent at all ages of the bird, while laterally, upon either side, the premaxillary, assisted by the nasal, surrounds an elongated, subelliptical narial aperture of no small size. The internarial space is largely filled in by the irregular bones of the turbinal series and by an imperfect, though true, nasal septum.

¹ Compare both text and figures of Prof. Parker's memoir on the "Morphology of the Skull in the Woodpeckers and Wrynecks" (*Trans. Linn. Soc. Lond.*, read 1874) with Garrod's "Note on Some of the Cranial Peculiarities of the Woodpeckers" (*Ibid.*, 1872, pp. 357-360, and his *Coll. Scientific Memoirs*, pp. 117-119), and the figure which illustrates the latter.

² For the details of this classification, see his *Untersuchungen zur Morphologie und Systematik der Vögel*, published at Amsterdam in 1888.

Turning to the skull of a nestling *Colaptes*, we are to note that the frontal processes of the bone under consideration slope *gradually* up on to the frontal region about equally as far as does a nasal on either hand. This cranio-facial region is likewise *sloping* in the adult, though further on we shall see that it is quite different in some other Woodpeckers.

Laterally, the maxillary process of the premaxillary overlaps the corresponding maxillary, so that in the adult, after fusion takes place, the two bones are indistinguishably united, and no suture or process thereafter marks the line of union. At the roof of the mouth, the palatine processes of the premaxillary behave in a similar manner; the prepalatine extremity being the bone that overlaps the backward-projecting process of the premaxillary upon either side. The apex of the premaxillary in all *Picidæ* is generally a little truncated off and squarely across.

Mesially, the premaxillary unites to some extent below with the nasal septum, as we so often see it in other birds wherein that partition exists.

Nothing of especial import characterizes the frontal and parietal bones in the cranium of a nestling *Colaptes*. Essentially they agree with the corresponding bones in the immature specimen of any ordinary passerine bird—a large Thrush, for example—where the external superficies of the cranial vault is smooth and rounded.

Owing to the relatively small squamosal, however, they in *Colaptes* descend far down laterally, and this feature can easily be guessed at from a glance at any skull of an adult Woodpecker, where it will be noticed that the lateral processes of the cranium are comparatively near down toward the quadrate.

The frontals and parietals of an adult *Colaptes* do, however, possess characters not yet evident in the skull of the nestling of any of that genus. In the first place, there is the denting of nearly the entire external surface of these parial bones, which is caused by the apices of the quill-butts of the capital feathers. Again, we note in this region, in the adult, the double impressed groove, leading from the supraoccipital prominence by a gentle curve to the posterior periphery of the right narial aperture. This double gutter lodges, as we know, the free ends of the hyoidean apparatus during the life of the individual. Adult *Colaptes* also exhibit a slight tilting up of the postero-superior orbital peripheries, the margins being sharpened and a few perforating foramina occurring



RIGHT LATERAL VIEW OF THE SKELETON OF THE PILEATED WOODPECKER.
(SLIGHTLY REDUCED.)

just within their borders, one behind the other down the line. The frontal region between the rims of the orbits above is but moderately broad, and barely concaved.

A nasal bone in the skull of the young *Colaptes* has the usual form seen among the higher passerine types; it is of the holorhinal pattern, and makes the usual articulations with the surrounding bones. As the bird matures a diminutive process is seen to appear upon its posterior margin between the anterior apex of the frontal and an abutting process thrown up on the part of the corresponding maxillo-palatine. Anteriorly it sends a jagged horn of some size forward into the anterior rhinal space. A true lacrymal does not develop in *Colaptes*. The pars plana is large, very complete and of a quadrilateral outline. Postero-externally it sends backward from its angle a long, pointed os uncinatum that normally bears upon the *inner* side of the jugal bar. *Colaptes*, agreeing with all our United States *Picidae*, exhibits considerable ossification of the turbinal series of bones, although there is a marked simplicity of the arrangement of them. One turbinal seems to be *free* upon either side, both in this and in other species. Parker has paid considerable attention to the turbinals of the *Pici*, and in briefly alluding to what he saw in other species, in the ninth edition of the *Encyclopædia Britannica* (article "Birds," p. 717), he says that "the 'inferior turbinal,' which has *three* coils in *Rhea* and *Tinamus* and *two* in most birds, is in *Gecinus* merely bi-alate; in *Junx* it makes less than a single turn, whilst the alinasal turbinal of that bird has two turns and that of *Gecinus* one. *Gecinus* is in all respects the most specialized, *Picumnus* the most embryonic and *Junx* the most passerine of the *Celeomorpha*."

In adult specimens of *Colaptes* the interorbital septum is usually entire, though it often shows a very minute central vacuity. When we come to examine other species of Woodpeckers, later on, we will see that this foramen in them is larger and more constant.

The infraorbital bar or zygoma is made up entirely of the jugal and maxillary, the quadrato-jugal not being present. It is straight and slender, being abruptly enlarged at the posterior or jugal extremity, where it is hooked inward to articulate with the quadrate.

Nestling *Colaptes* show the development of a fine pair of orbito-sphenoids, occupying their usual sites at the back of the orbits; and within these cavities, above either orbito-sphenoid, we observe the free edge of the frontal showing its advancing ossification. At

certain points this is peculiar, as little islets of bone occur along

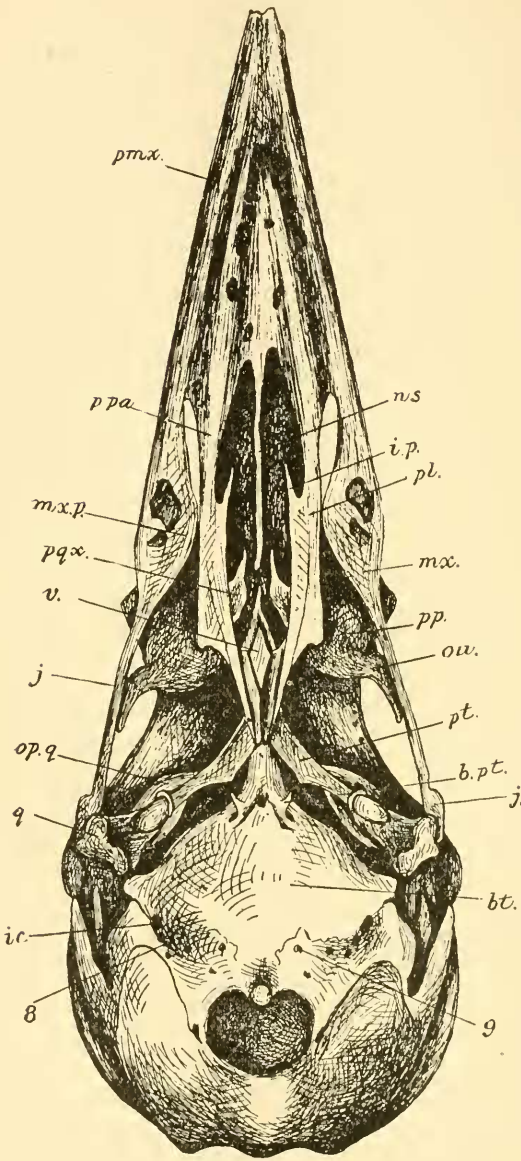


FIG. 1. Skull of adult male Pileated Woodpecker (*Ceophloeus pileatus*): under view, X 2, mandible removed. Drawn by the author. *pmx.*, premaxillary; *ppa.*, prepalatine; *mx.*, maxillary; *o. u.*, os uncinatum; *n. s.*, nasal septum; *p. p.*, pars plana; *pt.*, pterygoid; *ip.*, interpalatine spine; *j.*, jugal; *b.pt.*, basitemporal process; *mx.p.*, maxillo-palatine; *bt.*, basitemporal; *v.*, vomer; *pl.*, palatine; *p. q. x.*, palatine spur; *q.*, quadrate; *o. p. q.*, orbital process of quadrate; *i. c.*, foramen for internal carotid artery; *v.*, foramen for vagus nerve; *g.*, foramen for hypoglossal nerve.

this free edge, which are afterward absorbed by the main bone. This process occurs in other parts of the skulls of Woodpeckers.

Passing to the base of the skull, we see a number of points of interest in *Colaptes*, and some few features that are not present in the general run of ordinary existing birds. The basitemporal region is smooth, broad and deep antero-posteriorly. Nothing especially noteworthy characterizes the large foramen magnum, with its relatively small condyle, nor the foramina in front of it upon either hand. A supraoccipital prominence is also present, being but fairly developed, and never pierced by foramina in the adult individual.

Either tympanic bulla is cowrie shaped, showing a characteristic antero-posterior slit, and, according to Parker, this unique feature of the Woodpeckers is brought about by one of these bullæ being formed by not only the corresponding exoccipital, but by two, or more often several, tympanics (usually three). The basitemporal also enters into its formation (see Fig. 1).

A quadrate is of good size comparatively, with its orbital process stout and truncated at its apex. The "mastoidal limb" is short, and the mandibular facets peculiar. Either pterygoid is noted for its pointed and lengthened meso-ptyerygoid, which, when *in situ*, reaches forward to the palatine spur of the same side. On the upper edge of a pterygoid a prominent and pointed muscular process is developed; it has the same direction forward and inward as has the shaft of the bone. This shaft is thin and much compressed, while the quadratal head is small and inconspicuous. When articulated, the palatal heads do not meet mesially, or they may just barely touch each other. Occasionally we find in old specimens of *Colaptes* minute osseous "prickles" at the usual sites of the basiptyergoidal processes, and they represent aborted basiptyergoids. They are more prominent in certain other Woodpeckers of our avifauna, but it is only rarely that the corresponding process is ever seen upon the pterygoid. It is present, though very rudimentary, in a specimen of the Pileated Woodpecker before me.

The inferior border of the rostrum is rounded and not very thick transversely. It is very sharp in front, and below is usually carried out as a little spine. Either palatine is narrow, especially anteriorly beyond the maxillo-palatine, or what is known as its *pre-palatine portion*. Distally this extremity is underlapped by the palatine process (of the same side) of the premaxillary. Poste-

riorly the postero-external angle is obliquely truncated, and the head for the corresponding pterygoid is completely aborted, the palatine being simply drawn out at this end. About midway up its mesial border it develops a conspicuous interpalatine process, directed forward, while another free process, also directed forward, springs from that point on the bone where the bifurcation of the vomer articulates in a great number of ordinary birds. This last process, so variable and so conspicuous in nearly all *Pici*, I here designate as the *palatine spur*. During ossification of the mesial and external margins of either prepalatine minute islets of bone are left, and these may persist or they may not persist during the life of the individual.

The vomer, mesial in position, is situated rather far back between the palatines, and is non-bifurcated posteriorly. It is pointed in front and pointed behind, and rests for nearly its entire length upon the nether aspect of the sphenoidal rostrum. In some Woodpeckers it is quite compressed in the vertical direction and of somewhat of a lozenge-shaped outline. That it is not forked posteriorly need not surprise us, for that also is the case with the semi-rudimentary vomer in *Geococcyx* and some other birds.

The lower margin of the mid-lying nasal septum is long and scraggly; while above, the laminated portion of the bone is not completed up to the premaxilline roof. A maxillo-palatine is of considerable size, broad, horizontally flattened, perforated upon its nether side by foramina, and finally it sends backward from its mesio-posterior angle a blunt-like process. This last feature is absent in many *Pici*, and here in *Colaptes* the inner margin of a maxillo-palatine barely comes in so far as the outer border of the corresponding palatine, and so these bones are widely separated from each other in the middle line.

In *Colaptes* the mandible is of the typical V-shaped pattern, long and narrow, with a very shallow symphysis. Its ramal sides are rather shallow, upright and with rounded superior and inferior borders. A ramal vacuity is absent, or reduced to a mere pinhole or smaller. The angular extremities are rounded, and offer no special process on either side. This jawbone is pneumatic, and its hinder articular ends present the usual ornithic characters, with perhaps an arrangement of the mandibular facets peculiar to the *Pici*, but departing but little from what we find in almost all ordinary avian types. In the adult all the sutural traces among the splint-bones composing the mandible have disappeared.

A very curious condition of the sclerotical plates of the eyeball exists in *Colaptes* and all other American *Pici* wherein I have examined them. These plates very thoroughly fuse together, although in the nestling at the time it leaves the nest they are still separate. In the case of the sclerotals of a specimen of the big Imperial Woodpecker before me this fusion is so perfect that all the sutural traces among the plates have well-nigh disappeared entirely. Such a condition is not common among highly organized birds.

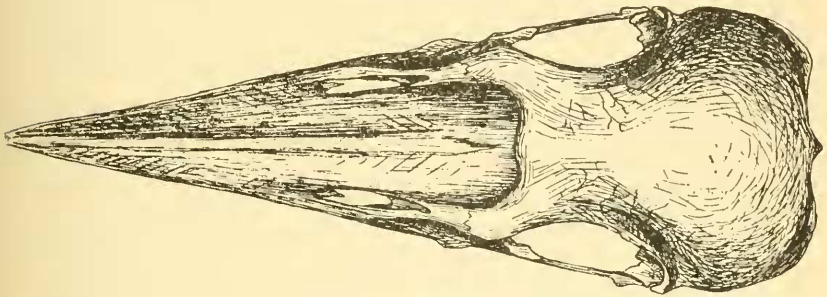


FIG. 2. Superior view, natural size, of the skull of the Imperial Woodpecker (*C. imperialis*). Drawn by the author from specimen No. 1464 of the osteological collections of the United States National Museum.

The present writer has not paid any very special attention to the bones of the ear in the *Pici*, but Parker has said of them for *Geococcyx viridis* that "The stapedial apex of the largely aborted second postoral arch has some peculiarities of importance. The true stapedial or periotic portion is rather large and roughly oval, the side toward the 'opisthotic' bar separating the fenestra ovalis from the fenestra rotunda being straightest.

"The *capitular* portion of the arch, continuously ossified with the base, is the flattish 'medio-stapedial'; a bony rod from this bar runs down the anterior 'infrastapedial' bar, bringing to mind the small bone in the 'stapedius' muscle of the mammal; it is its *symmorph*. This double 'infrastapedial' is new to me; it ends below in a spatulate stylohyal, which has a proximal ossicle just below the infrastapedial fenestra. The extrastapedial is falcate and broad-backed; the 'suprastapedial' is small; and from it and from the proximal end of the extrastapedial a fibrous fan arises, which supplements the small 'tubercular' head of this facial rod. The

proximal portion of the large 'stapedial fenestra' is hidden in this view; but it scoops the falcate 'extrastapedial' beneath its thick outer or back part" (*Trans. Linn. Soc.*, read 1874, p. 10).

Passing to the *hyoidean apparatus* of *Colaptes*, we are to observe that the epibranchials of the thyrohyals are exceedingly slender rods of bone, and have their extremities resting just within the posterior periphery of the right external nostril.

In specimens before me the *left* epibranchial is several millimetres longer than the right. From this point they lie along in the groove on top of the skull, and curving round behind the cranium, join similar-fashioned ceratobranchials at points about opposite the position of the vomer. The ceratohyals are small and fuse together to form a delicate arrowhead-shaped bone, which articulates posteriorly with the long, single, highly ossified basi-branchial. There is no urohyal.

Other *Pici* have the epibranchials curl round the orbit as in the genus *Picus* (see Fig. 6). We are now in a position to make certain comparisons with the skulls of other *Pici*, comparing them with those structures we have just had under consideration in *Colaptes*, and first let us take up the skulls in certain species of *Melanerpes*.

Melanerpes torquatus (Lewis's Woodpecker) offers us some wonderfully interesting differences. It possesses a comparatively broad skull, with ample brain-case, which latter is externally rounded and smooth. In the frontal region it is rather broad between the superior orbital peripheries. The grooves for the ends of the hyoid are very shallow, barely perceptible, and then only occur no farther forward than the postfrontal region. At the cranio-facial hinge, which is directly transverse, the frontals very slightly roll over on the nasals and the premaxillary. This remarkable picine character is far more distinct in other genera. We find the interorbital septum absolutely entire in the adult, while a very ample quadri-form pars plana is seen, but a distinct os uncinatum does not appear to be present, and the angle where it occurs is not especially produced.

Although the tympanic bullæ are somewhat cowrie-shell shaped, they are by no means so conspicuously so as they are in *Colaptes* and some other forms. The basiptyergoidal processes are notably rudimentary, and hardly to be seen in some skulls of this species. Picine in their general pattern, the pterygoids show but a compara-

tively reduced process on either one for muscular attachment, and when articulated *in situ* they are seen to touch in the median line.

Either palatine has its internal and external laminae rather more curled downward as compared with the thin, horizontally flattened bones of *Colaptes*. The postero-external angle in each develops a definite process, which is directed backward. Individuals vary with respect to the lengths of the palatine spurs, they being markedly longer in some than in others, but *their anterior ends are always free* in this species. Inner and outer borders of the palatines are *not* ragged, but very smooth and straight, inclining one to believe that the ossification along them is different from what I described for *Colaptes*. A free turbinal is found in either rhinal chamber. The maxillo-palatines are very much reduced, and strikingly narrow transversely, while the vomer appears to be absent. I examined seven specimens to satisfy myself of this latter fact. The posterior reduced ends of the hyoidean apparatus only reach up to the vault of the cranium; they are very elastic even in the long dried skeleton, and moreover they are *flattened* in the vertical direction.

In the mandible the symphysis is relatively deeper than we found it in *Colaptes*, and the foramen in either ramus a little larger.¹

Our Red-headed Woodpecker (*M. erythrocephalus*) essentially repeats what we have just described above for *M. torquatus*. In 1879 I collected an old male of this species at Fort Fetterman, Wyo., and its skeleton is now at hand; since then several specimens have been presented me, and chiefly by Dr. Strode, of Bernadotte, Ill., to whom my thanks are due for them.

A vacuity may or may not exist in the interorbital septum of the Red-headed Woodpecker, and at the cranio-facial hinge the rolling forward of the frontals is not nearly so evident. The ends of the hyoid come higher up on the skull, reaching as far forward as the mid-point between the orbits. The muscular process on either pterygoid is purely rudimentary, and I fail to find a lacrymal in any of this genus. No vomer is developed, but in a specimen before me the beak of the rostrum supports a curious hairlike spine extending forward in the middle line for several millimetres. In

¹I am not quite confident that the ramal vacuity we find in the jaws of *Colaptes*, *Melanerpes* and the Imperial Woodpecker corresponds with the true ramal foramen as seen in other birds (Passeres). Careful comparisons rather incline me to think that it does not.

the mandible the posterior angular process is inclined to be slightly more produced.

Superficially, the skull of *Melanerpes uropygialis* almost resembles that of some of our more delicately structured Thrushes.¹ All the bones composing it are notably thin and semi-transparent, more especially those of the brain-case and frontal region. There is an os uncinatum present, while the interorbital septum is, as a rule, entire. The lower border of the nasal septum ossifies, and the anterior border of the external narial aperture is curled inward to meet the same of the opposite side. Mesially, these coössify and form a transverse partition at the point in question. Viewing this skull from above, we find the cranio-facial region much as it exists in *Colaptes*—that is, the frontals do not bulge over the ends of the premaxillary. None of the birds in this genus seem to have the external vault of the cranium dented by the butts of the quills of the capital feathers, and the ends of the hyoid rarely reach so far forward as the mid-point of the frontal space between the superior margins of the orbits. In this Gila Woodpecker we find the palatines much the same as they exist in *M. torquatus*, and the same remark applies to its mandible and hyoidean apparatus.

Melanerpes carolinus has the skull and associated parts very much like the corresponding structures in *M. uropygialis*, though, nevertheless, it has a specific *facies* of its own—a *facies*, however, that would compel the comparative osteologist to sink to insignificant details to define. But, exasperating as this puzzling intergradation is among the skeletons of these Woodpeckers, it is an exceedingly interesting picture to take in by the eye.

In *M. carolinus* the tympanic bullæ are so reduced as hardly to call to mind the cowrie-shell-shaped cavity at all, and the 'slit' is comparatively wide. We find in this skull also that the postero-external angles of the palatines to be *rounded* off, thus differing markedly with *M. torquatus* in this particular. No vomer is present. Maxillo-palatines are very narrow, and an os uncinatum seems to be absent. *M. aurifrons* has also been examined, but requires no special comment.²

I have also examined skulls of the Narrow-fronted and California

¹ Owing to the kindness of my friend Mr. Herbert Brown, of Tucson, Ariz., I have skeletons of both male and female specimens of this species.

² I am indebted to Mr. F. Stephens for several specimens of this species.

Woodpeckers of this genus, and they all present essentially the main cranial characters alike.

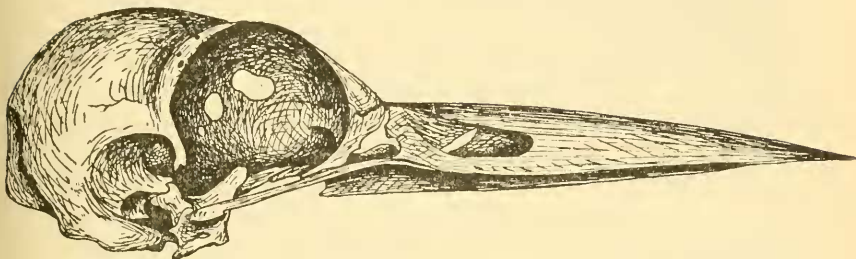


FIG. 3. Right lateral view, life size, of the skull of the Imperial Woodpecker mandible removed; same specimen as shown in Fig. 2.

Ceophlæus pileatus is a very large Woodpecker, and the sole representative of its genus in this country. Its skull and associated parts present us with a number of characters of interest, some of which are different from those discussed in *Colaptes* and *Melanerpes* (see Fig. 1). Two skeletons of this pileated Woodpecker are before me, and both are from adult males. One of them has a skull eight centimetres long by nearly three centimetres wide at its widest part over the quadrates. Viewing it from above, we are struck by the great width of the superior osseous mandible, especially at its base. This part of the skull is much compressed from above downward—a fact which has its due effect upon the form of the external narial apertures. The frontal region slopes gradually down upon the premaxillary over the cranio-facial hinge. As in *Colaptes*, the gutters for the accommodation of the ends of the hyoid are very distinct, and that apparatus passes to the right nostril, as in the form we have just mentioned. For the rest, on this aspect of the skull in the Pileated Woodpecker, we find a handsomely rounded cranial case, which is pitted all over the parietal and postfrontal regions in a manner already noted for other forms above. Looked at from behind, we note a well-marked supra-occipital prominence, while farther along, on either hand, the tympanic bullæ are unusually well developed, having the picine character of these parts brought up to their comparative maximum size. Coming to the infraorbital bar, we find it composed only of the jugal and maxillary, the two forming a straight, stout rod, which is laterally compressed, and enlarged and hooked at its

proximal end. The interorbital septum exhibits a rather large subelliptical vacuity at its centre. Pars plana is large and thick through antero-posteriorly; its lower outer angle is produced backward by a long os uncinatum. Rudimentary basiptyergoidal processes are present, and the corresponding vestigial apophyses are to be seen upon either pterygoid. Otherwise these latter are much as we find in the *Pici* generally, the hooks for muscular attachment being well produced. Mesially, between the palatine a large vomer is seen to be present; it has the form of a spear-head, with its anterior angle produced forward as a delicate spine. Turning to a palatine bone, we find it narrow and straight, and of nearly equal width throughout. Its postero-external angle is bluntly produced, while behind it makes the usual picine articulation with the pterygoid of its own side. The palatine spur is *short*, freely pointed in front and appears more as an outwardly curled part of the palatine lamina proper. It is curious in possessing a distinctly produced process upon its outer aspect near the middle. This form of the palatine spur is quite different from that of any other Woodpecker that I have ever examined. Running forward from the apex of the interpalatine spine there is a ragged string of subossified tissue that is again anchored in front to the mesial border of the bone. In this structure we may find several islets, of an elongated form, of true bone. I consider them to be, as I do in other species already mentioned, detached parts of the prepalatine, which is but poorly ossified along the border in question. This imperfect mode of ossification is extended to the mesial subnaso-septal bar, which we here find to be composed of the same subosseous tissue containing elongated granules of true bone. Detached turbinals are found in the narial chambers of the Pileated Woodpecker, but these parts seem to depart but little from what has already been described for other picine types.

There is a special character that should be noted in the skull of *Ceophleus*, and it is the *raised* osseous line that runs mesially down the column of the premaxillary. This character is well seen in the Imperial Woodpecker also, but is absent in representatives of the genus *Colaptes* and *Melanerpes*.

Our Pileated Woodpecker has a very strong mandible, of a form usually seen among birds of this group. Posteriorly the ramus is deep in the vertical direction, and the downwardly convexed border below is here much roughened, a character it exhibits in com-

mon with the Imperial Woodpecker (see Fig. 4). Imperfect as the skull of the individual of this latter species is that I have for examination, it yet presents us with a number of very important characters.¹ Upon superior aspect, this skull has the general characters of the skull of a Pileated Woodpecker; it differs, however, in having the bones of the frontal region to some extent bulging over the broad superior base of the premaxillary (see Fig. 4). Relatively the vault of the cranium in *C. pileatus* is higher

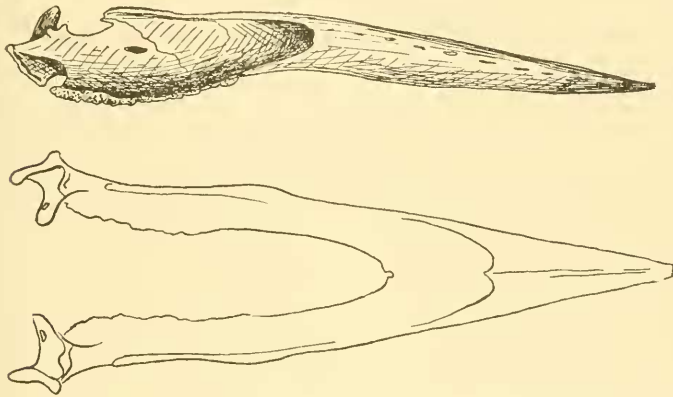


FIG. 4. (Upper one.) Right lateral aspect of the mandible of the Imperial Woodpecker.

FIG. 5. (Lower one.) Superior view of the same bone and in outline. Both figures natural size and drawn by the author from the mandible belonging to the skull shown in figure 2.

and more rounded than it is found to be in the Imperial Woodpecker; in other words, the brain-case, and consequently the contained cephalic mass, is larger in the first-mentioned species than it is in the last. I have not the skull of an Ivory-billed Woodpecker at present for examination, but am inclined to believe that it will be found to resemble the skull we now have under consideration, and its chief points of difference with what we found in the skull of *C. pileatus* are seen to refer to the palatine bone. This

¹ The specimen belongs to the collections of the United States National Museum (No. 1464). It lacks the pterygoids and hyoidean arches, and I am inclined to believe that the vomer has also been lost. The collector, however, preserved the sclerotals of one eye, and it is remarkable to see how completely they are fused into one circllet of bone.

element is most remarkably modified, for, in the first place, it is comparatively very narrow, being nearly of an equal width throughout, while its postero-external angle is completely rounded off. Then, again, the palatine spur starts from the palatine proper (at the usual site), first as a delicate, half-turned whorl of bone, which is extended *directly* forward as a *fine* osseous thread fully two centimetres long. The anterior end of this latter coössifies with the mesial margin of the prepalatine, satisfying me of the fact that it is nothing more than a semi-detached part of the palatine, it being ossified with it at both extremities.

Plenty of skeletons of the several species of the genus *Sphyrapicus* are to be found in my private cabinets, and when we come to study the skull and associated parts of one of these peculiar Woodpeckers we are met by a number of characters not seen in the picine skulls already considered above. Viewed upon superior aspect, the cranium of *S. thyroideus* is broad, rounded and smooth, calling to mind these parts as they appear in any small, ordinary passerine bird. The denting caused by the capital feather quills is only seen faintly in the fore part of the frontal region, which in these birds is very broad between the orbits. This breadth is extended to the base of the premaxillary, and this broad base runs quite abruptly to the apex of the upper mandible. This part of the skull is also much compressed vertically, causing the external narial apertures to appear quite slit-like. To some degree the frontals bulge over the premaxillary about as much in comparison as they do in the Imperial Woodpecker. Seen laterally, this skull presents us with a large pars plana, but apparently no os uncinatum. Internally the pars plana curves well backward, while on the other hand the anterior wall of the brain-case curves correspondingly forward. This all very much reduces the size and extent of the interorbital septum proper, which is here unpierced by any fenestra. The morphology of the turbinals is practically the same as in other *Pici* already considered, and a large free turbinal exists in the species of this genus. Either jugal-bar is short, straight and slender, articulating in the usual picine fashion with its quadrate behind. And this last-named element is strictly upon the Woodpecker model, while in the case of the pterygoid, its "snag" for muscular attachment is very long, and the palatine heads of these bones do not meet when articulated *in situ*. Further, the mesopterygoid does not reach as far forward as the palatine spur of the palatine of the corresponding side.

With respect to the palatines, they are interesting from the fact that the palatine spurs curve toward each other and the median line; but more than this, for when either of them passes the interpalatine spine of its own side it presents a shoulder for the apex of the latter to fit upon, while after this the palatine spur is continued forward as a delicate osseous spine for a short distance. There appears to be no vomer present in *Sphyrapicus*, and the maxillo-palatine are more than ordinarily reduced in size, while the great comparative breadth of this part of the skull takes them away still further from the prepalatine on either side.

As is well known, the hyoidean arches in this genus of Woodpeckers, although morphologically like others of the suborder, they nevertheless exhibit the notable feature in not having the thyro-hyals curve back over the cranium any more than they are seen to do in ordinary passerine birds.

The mandible is as in other *Pici*, with its symphysis rather deep and the posterior angular processes slightly more conspicuous. The ramal vacuity is entirely absent.

Quite a gap must exist between *Colaptes mexicanus* and such a form as *Picooides arcticus*—that is, if we be guided by what their skulls seem to indicate. In *Picooides* we meet with a skull that is possessed of a relatively very large cranial casket, globular and every way elegant in the extreme. It is uniformly and handsomely dented all over by the quill-butts of the capital feathers and is distinctly grooved for the thyro-hyals of the hyoid as far forward as the cranio-facial hinge. The frontals and nasals conspicuously roll over the premaxillary base, but the line here is not directly transverse, as it makes an obtuse angle, with its aperture looking forward.

The superior osseous mandible is very wide at the base, straight, vertically much compressed, causing the slit-like external narial apertures. These latter have their superior margins slightly tilted upward, as though the flattening of this mandible was becoming too great, and the nostril had made an effort later to enlarge its aperture.¹

¹ Some meaning, too, must be attached to the peculiar way the frontal region bulges over the base of the premaxillary; possibly the continual hammering these birds indulge in to obtain their food may have in time produced this condition. At any rate it has the appearance as though the premaxillary had been pushed into the fore part of the skull. I have noticed, too, that it is in the skulls of the most inveterate hammerers that this feature is best developed. It is scarcely noticed at all in *Colaptes*, indeed it is quite absent there.

Parker often speaks of having found a lacrymal in the Woodpeckers, and here in *Picoides* one certainly seems to exist, and it is represented by quite a sizable flake of bone semi-attached to the posterior margin of either nasal. It may explain the little bit of a nib of a process found at the same point upon the nasals of some other *Pici*—*Ceophlæus*, for example. *Picoides* has an orbit that is veritably cup-shaped, which reduces the interorbital septum to almost *nil*, and proportionately the partition here between the orbits is quite as thick as it exists in certain caprimulagine types. Notwithstanding this a sizable fenestra pierces the septum in question. Os uncinatum, if present, is extremely rudimentary in character, while a foramen pierces the pars plana just within its external margin about midway up the plate. Other *Pici* show the same character.

Directing our attention next to the base of this skull, we are at first struck with the remarkably small size of the pterygoids, and this is enhanced by the relatively great proportions of the dome-like cranium that overshadows them. Each one develops a conspicuous "muscle-process," and the mesopterygoid is interesting from the fact that it is more paddle-shaped than in any other Woodpecker I have thus far examined. They do not reach forward to the hinder ends of the palatine spurs of the palatines, but hold a position more as we find it among the *Passeres*. The basiptyergoid processes are entirely absent. A nasal septum ossifies anteriorly and is represented by a mesial thread of bone and small, semi-detached plates. I fail to find a vomer present in this species, but it may be very rudimentary; at any rate there is not much room for it at its usual site under the rostrum, for here the palatine on either side curls closely up upon the nether surface of that bar, and in a way I have not observed in other Woodpeckers. Perhaps the small vomer was lost during maceration; and at the present time I have but one skeleton of *Picoides arcticus*.

The posterior moiety of either palatine bone is but slightly wider than its prepalatine portion. For its whole length it is flattened, and the postero-external angle is inclined toward producing a process, which is directed bluntly backward and outward. A palatine spur is represented by a scraggly thread of bone, which on the right side passes forward above the interpalatine spine, to become attached again to the mesial margin of the palatine farther along. On the left side this connection is not made, so we have the usual

palatine spur, and further along on the edge of the palatine, anterior to the interpalatine spine, we find a thread-like retral process, which condition is similar to what Parker saw in *Geococcyx viridis* and other picine types on *both* sides.

Maxillo-palatine lobes are very small, and upon either side they are even markedly well separated from the corresponding palatine.

In *Picoides* the ends of the thyro-hyals of the hyoidean apparatus seem to extend no farther forward than a point opposite the cranio-facial hinge; while, with respect to its mandible, it only need be said that in it the symphysis is deep, and the posterior angular processes especially well produced for a Woodpecker. There is no ramal fenestra present.

Macgillivray, in speaking of the arrangement of the hyoidean extension over the skull in United States *Pici*, in Audubon's *Birds of America* (Vol. iv, pp. 288-289), says:

"In *Picus varius* the tips of the horns of the hyoid bone reach only to the upper edge of the cerebellum, or the middle of the occipital region.

"In *Picus pubescens* they do not proceed farther forward than opposite to the centre of the eye.

"In *Picus principalis* they reach to a little before the anterior edge of the orbit, or the distance of half an inch from the right nostril.

"In *Picus pileatus* they extend to half way between the anterior edge of the orbit and the nostril.

"In *Picus erythrocephalus* they reach to three-twelfths of an inch from the base of the bill.

"In *Picus tridactylus* they reach the base of the ridge of the upper mandible.

"In *Picus auratus* they attain the base of the right nasal membrane.

"In *Picus canadensis* they curve round the right orbit to opposite the middle of the eye beneath.

"Lastly, in *Picus villosus* they receive the maximum of their development and curve round the right orbit, so as to reach the level of the posterior angle of the eye."

This agrees very well indeed with the present writer's observations, but Macgillivray did not seem to take into consideration the fact that the ends of the hyoid exhibit *two* inclinations—one as in

Colaptes, where they essay to enter the right nostril, and the other as in *Dryobates*, where they essay to curve round the right orbit.

Now, in *Xenopicus albolarvatus* they reach far forward and exhibit an evident tendency to curve round the right orbit and succeed in coming down pretty well in front of it.

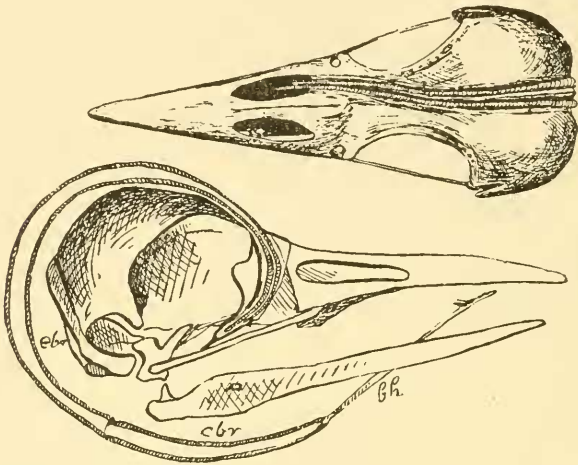


FIG. 6. (Upper one.) Superior view of the skull of *Colaptes auratus*, life size, showing the manner in which the thyro-hyals of the hyoid pass to the right nostril.

FIG. 7. (Lower one.) Right lateral view of a skull of a *Picus*, designed to show the second method by means of which the extremities of the hyoid are stowed away around the right orbit. *bh.*, basihyal; *cbr.*, cerato-branchial; *ebr.*, epibranchial. (Taken from Coues's *Key*, and both figures drawn by the present writer.)

Consequently, in *Xenopicus* we find the usual groove on the top of the cranium for the ends of the thyro-hyals and the rounded vault of the parietal and frontal regions. These are well dented by the quill ends of the capital feathers. This species of Woodpecker has a skull most nearly approaching that part of the skeleton in some forms of *Dryobates*, and reminds one but very little of any of the skulls in either *Spyrapicus* or *Melanerpes*.

In form the superior osseous mandible in *Xenopicus* is typically picine, being quite unlike what we find in such types as *Colaptes* and *Melanerpes torquatus*. At the base of the skull it is interesting to note that in this comparatively rare species there appears to

be a complete abortion of the basipterygoid processes, and there is certainly no vomer. On the pterygoids the muscle-process is but fairly well developed. On the palatines the interpalatine process is inconspicuously pronounced, while either "palatine spur" is delicate and passes forward to fuse with the mesial margin of the palatine from which it arises. A moderately large os uncinatum is seen and a small subcentral fenestra pierces the interorbital septum. Contrary to what we have found usually to obtain, a ramal vacuity of some size pierces the ramus of either side of the mandible.

When we come to compare the trunk and appendicular skeleton of *Xenopicus* with the corresponding parts of the skeleton of, say, such a species as *Dryobates villosus*, we will find still other points of resemblance between them. Just here, however, we pass to the consideration of the skull in the last-named species, which is the form I have selected to represent the genus to which it belongs. At the present writing I have beautiful skeletons of *D. villosus* before me, which I prepared from specimens collected for me by Dr. W. S. Strode, of Bernadotte, Ill.

Elegant in form and structure and eminently picine in character, the skull in *Dryobates* is truly a most interesting object to study. Externally the vault of the cranium is beautifully rounded and handsomely pitted by the quill ends of the capital feathers; further, a double gutter for the ends of the hyoidean apparatus is unusually distinct. The superior orbital rims are slightly tilted upward, and just within the margin of either one of them occur perforating foramina. Between these borders the frontal region is rather broad, while in front, between the nasals, it rolls or bulges well over the consolidated extremities of the premaxillaries. The superior osseous mandible is especially picine in character, being rather wide posteriorly, compressed vertically and directly drawn to an acute apex anteriorly. As already remarked, on its superior aspect it is *pushed into* the frontal boss behind. The culmen is represented by a raised ridge extending down the middle line to the apical extremity. Either external narial aperture is rather ample; the line of the lower margin of the opening being curved, while superiorly it is straight. Within the narial chamber the arrangement of the turbinals is as we have described them above from Parker. I would add, however, that the *free* turbinal upon either side is large and composed entirely of bone.

Upon lateral aspect we are to note that the "infraorbital bar" is very slender and straight; it is without a quadrato-jugal. Pars plana is ample and much curved and there is a fairly well-developed os uncinatum. The interorbital septum is a thickish plate, which shows a good-sized vacuity near its centre. Still more posteriorly it will be seen that the sphenotic and squamosal processes are both conspicuously developed, while anteriorly the nasal is very slender. By their approaching each other the long sphenotic process and the os uncinatum come within one-fifth of completing the orbital periphery, and the orbital cavity itself is deep, capacious and cup-shaped. Either tympanic bulla, although not strikingly large, has the usual cowrie-shell shape so characteristic of the skulls in the birds we have now under consideration.

I find no evidence of any basiptyergoidal processes, and the basitemporal region is broad and smooth. Mesially the pterygoids nearly meet each other, and either one of these bones supports a conspicuous muscle-process. As for the mesopterygoidal portion of a pterygoid; it is rather broad and by no means reaches as far forward as the palatine spur of the palatine bone of its own side. A quadrate is as we find it in the *Pici* generally, but it is to be noted that the extremity of its orbital process is slightly expanded. Coming to a palatine, we are to observe that the post-palatine plate is slightly concaved upon its nether side, its postero-external angle is rounded off, and this entire division of a palatine bone is quite evidently separated from the prepalatine or more horizontal portion by a subconstriction just anterior to the spiculiform interpalatine spine. The palatine spur is strongly developed, and, as in *Xenopicus*, completely fuses anteriorly with the mesial edge of the palatine to which it belongs. This fusion of the anterior end of the palatine spur is at some distance in front of the interpalatine process, while opposite this last-named projection it often sends out a little osseous shoot that makes the feint to join with its apex—that is, with the apex of the interpalatine spine. A well-marked vomer is present, having the usual form and occupying the usual place, as is seen in the *Pici* generally, and which I have fully defined above. A thin or often thread-like septum narium also ossifies in this species of Woodpecker, and this extends backward for a variable distance in different individuals—in the example before me as far as the middle point midway between the very much aborted maxillo-palatines. These latter are really more reduced than in any Woodpecker with which I am acquainted.

Passing to the mandible of *Dryobates*, it is seen to have the common V-shaped pattern of the Pici generally, with its symphysis rather deep, with its posterior angular processes well-marked, and with quite a sizable ramal vacuity in either of its rather vertically deep rami.

As has already been stated above (in the table quoted from Macgillivray's synopsis in Audubon), the hyoidean apparatus in *Dryobates* (*Picus*), in so far as its skeletal parts are concerned, is typically picine, and when the ends of the thyro-hyals arrive as far as a point opposite the light nasal bone they curve, and thence on pass nearly round the outer rim of the right orbit. The ear-bones I have not especially examined in this species, but they probably very closely agree with what Mr. Parker found in other Woodpeckers, and on this point I have quoted him above. With respect to the sclerotals of the eye, I find them in *Dryobates* quite like what we have given above for the Pileated Woodpecker and other forms.

This is all I have to say in the present place about the skull and the osseous structures more or less nearly associated with it in the *Pici*, so that next we will pass to the consideration of the remainder of the skeleton in this group of birds. Our remarks upon the skull were led in by an examination of that structure in the genus *Colaptes*, so back to *Colaptes* we go for material upon which to base our remarks upon the trunk and appendicular skeleton.

ON THE SKELETON OF THE TRUNK AND LIMBS IN THE WOODPECKERS.

Upon examining the vertebræ of the vertebral column of a specimen of *Colaptes mexicanus* at about the time the bird quits the nest, we find that there are nineteen of these bones between the skull and pelvis, which is the same as we will hereafter find in all true passerine types.

These vertebræ in the young *Colaptes* ossify from the same number of centres, and after the same fashion as they ossify in all of the higher groups of birds. *Ten* more vertebræ seem to enter into the formation of the pelvic sacrum; and, excluding the pygostyle, *six* more free ones compose the skeleton of the tail. Later on we will allude more particularly to these segments of the entire spinal column, and the peculiarly formed one that terminates the chain behind. The pelvis at this age still faintly shows the sutural traces

that indicate the boundary lines among the three bones that enter into its composition upon either side of the sacrum. Even at this age it is already strongly indicated that its sides are to be deep, its basin capacious, and its preacetabular portion comparatively narrow (see Figs. 9 and 10).

A rudimentary riblet may be suspended upon either side of the twelfth cervical vertebra, and a better developed pair occur on the thirteenth, while on the fourteenth cervical the pair of ribs, although freely suspended, possess well-marked epipleural or unci-form appendages.

These latter are very large on the fifteenth, sixteenth and seventeenth pairs of ribs, small on the eighteenth, and entirely absent on the nineteenth, as they also are on the pair of sacral pleurapophyses. The four pairs of true dorsal ribs articulate with the sternum through the intervention of sternal or costal ribs, and the anterior pair of these latter are very conspicuous from their unusual bigness—not so much so in this nestling, however, as they are in the full-grown *Colaptes*, and still more so in adult individuals of other species of our *Pici*. Regarding the hæmapophyses of the sternal ribs, or rather pair of ribs, we observe that they do not reach so far as the costal border of the sternum upon either side. At this age the sternum is but subdeveloped, showing but imperfectly the pair of notches on either side behind, while the carina is shallow and the manubrial process not complete.

With respect to the shoulder-girdle in this young Red-shafted Woodpecker, I find that the hypocleidium is absent from the os furcula, and that this bone has its upper ends pointed. In front of either of these points we observe a flat, triangular piece of bone of some considerable size that lies against the head of the coracoid and the anterior extremity of the scapula of the same side. This piece ultimately fuses with the end of the clavicle, and thus either end gets to wear the form of the bone as we find it in the adult *Colaptes*. Probably this method of formation is common to all of our species of Woodpeckers.

The distal ends of the scapulæ are slightly expanded and rounded, and as yet but faintly suggest the peculiar form they take on in fully matured individuals.

Nestlings very imperfectly show the pneumaticity that eventually comes to so generally obtain in the pectoral extremity of the old birds of this species and some other *Pici*—for representatives of

this group have this feature quite strongly marked in their skeletons. Further consideration of this limb shows the presence of a good-sized os humero-scapulare; it shows the papillæ along the shaft of the ulna for the ends of the quills of the secondary wing-feathers; it shows the presence of a rudimentary sesamoid at the elbow; and it shows, even at this early age, the ossicles at the wrist number but two free ones, all the others having duly fused with the proximal extremity of the metacarpus. Peculiarities of the bones composing the hand can best be studied in old birds, which we will do further on.

Upon examining the skeleton of the pelvic extremity in this nestling, I find ossification of the several bones composing it so far advanced that nothing would be gained by a description of them in their present state, and it will be better to study them also in a matured individual. Students will comprehend just how rapid this ossification has been when I tell them that even at this early stage of this Woodpecker's development the line of sutures between the condyles and the lower end of the shaft of tibio-tarsus has been absorbed, a condition which likewise obtains in the femur. A goodly patella has also ossified.

Taking up next the skeleton of an old individual of *Colaptes mexicanus*, we find some very good characters in its vertebral column, in addition to those described above. With respect to the atlas, it is peculiar in having the vertebrarterial canal, upon either side, *completely enclosed by bone*. It also has a very broad neural arch, and its cup for the condyle is unperforated in many specimens. In the axis we find both neural spine and hypophyseal process prominently developed, and in this vertebra the vertebrarterial canal is also present and of some length, being enclosed by bone. Both atlas and axis are highly pneumatic, as are all the free vertebræ of cervical and dorsal regions. This not only obtains in *Colaptes*, but in other *Pici*. Conspicuous neural spines are also seen upon the third and fourth vertebræ, with less evident hypophyseal ones. In both these last a broad interzygapophysial bar exists upon either side, and with regard to the remaining cervical vertebræ they are chiefly noted in not possessing parial parapophysial spines, those processes so characteristic of the mid-cervical vertebræ in the vast majority of the *Passeres*. Zygapophysial processes in these vertebræ are short and thick, which fact lends a peculiar

solid appearance to the mid-cervical segments from a posterior view. A hypopophysial canal is well marked, and this in the tenth, eleventh and twelfth vertebræ is replaced by very large and strong processes.

Among these segments the usual form of articulation that we find in the highest groups of birds prevails both anteriorly and posteriorly.

In the dorsal division of the spine large neural spines are present and the diapophyses are long and broad, developing at their outer extremities, above, short spine-like metapophyses.

Pneumaticity obtains in the case of the thoracic ribs, and these bones are rather wide in the antero-posterior direction and compressed transversely. The epipleural appendages are broad and not lengthy, usually in any case only reaching to the middle of the next succeeding rib. They always fuse with the margin of the latter.

Foramina for the admission of air are likewise to be seen at the ends of the true costal ribs.

Very spreading and somewhat downwardly-inclined transverse processes characterize the six free caudal vertebræ in *Colaptes*. Their centra are small and the bones are not pneumatic. The neural canal is almost capillary in its calibre, while in the two ultimate segments a coëssified, strong chevron bone is seen, which is likewise pierced antero-posteriorly in the last one by a foramen. This foramen is also carried on through the lower part of the peculiarly formed pygostyle. The neural spine of the last-mentioned is lofty, being thin-edged in front and on top, while posteriorly it is thicker. This bone also coëssifies with the caudal vertebra next in front of it, the transverse processes of which remain undiminished in size. Behind, the pygostyle at its lower part flares out as a broad, transversely-disposed hexagonal plate of bone, constituting a well-known character of the *Pici*.

So far as number of vertebræ is concerned and arrangement and number of ribs, *Dryobates* essentially agrees with *Colaptes*, but in the former we find some interesting morphological differences. In *Dryobates* the cup of the atlas is always perforated, and at the sides of this bone, either upon one side or the other, the osseous span for the vertebrararterial canal may not be quite complete, while on the other hand the hypapophysial canal for the carotid artery is entirely surrounded by bone, and the union below is firm. The last five cervicals support long hypopophyses which are narrower

in mid-series than they are at the ends; the leading dorsal vertebra also bears one of these processes, while the neural spines to the last-mentioned are lofty and comparatively narrow antero-posteriorly, and a somewhat reduced one is found on the last cervical. Epipleural appendages are seen upon all the true dorsal ribs, but they are absent from the extremely slender pair of sacral ribs. The last pair of cervical ribs are peculiar in being very stout and broad, and from this pair backward through the dorsal series they diminish in width. Most curious of all is the great size of the anterior pair of sternal ribs, and it is not clear to me at the present writing why they should be so. There is no canal passing through the ultimate chevron bones and the lower part of the pygostyle in the skeleton of the tail in *Dryobates*. Excepting a few minor departures, the part of the skeleton we have now under consideration in the Ivory-billed Woodpecker essentially corresponds with what we see in the last-mentioned genus. *Campephilus*, however, does not have its carotid canal completely closed in—the canal is found through the chevron bones of the caudal vertebræ—and a very high state of pneumaticity exists throughout. *Xenopicus* likewise agrees, as does the Pileated Woodpecker (*C. pileatus*), and in it the chevron bones are pierced by a canal which is extended through the enormous pygostyle of this bird. It, too, has the vertebrarterial canals of the atlas and axis entire.

Picoides arcticus presents us with nothing in its vertebral column and ribs in any way at variance with what we have in general found among other Woodpeckers above. In it, as usual, the atlas is pierced on either side for the vertebrarterial canal, and the carotid canal is slightly open in mid-cervical series, but completely closed and very small in the last vertebra or two. Nineteen free vertebræ are found between skull and pelvis, and six with a large picine pygostyle in the skeleton of the tail.

In a specimen of *Melanerpes erythrocephalus* at my hand I also find nineteen free vertebræ from occiput to pelvis, with six free tail vertebræ and a pygostyle. Generally speaking, the characters of these and the ribs connected with them are much the same as we have already described above for representatives of other American picine genera, but still there exists a specific shading difference hard to define. The vertebrarterial canal or foramen is closed in by bone on one side, open on the other in the case of the atlas, and the cup of this bone is largely perforated by an odontoidal fenestra. The

ribs appear to be slenderer and the hyapophysial processes of the last cervical vertebra not so strongly produced. A foramen, median in position, perforates the lower part of the pygostyle, as I have called attention to in some other Woodpeckers.

The first pair of sternal ribs are comparatively not so stout as they are seen to be in *Dryobates*.

Coming next to consider such a form as *Melanerpes torquatus*, we find the same plan prevailing; in it, however, the pre- and post-zygapophyses of the mid-cervical region are rather more spreading; the upper parts or moieties of the dorsal ribs are again broad; the leading pair of hæmapophyses are barely larger than the remaining pairs. This is quite a striking difference as compared with what we saw, for instance, in *Campephilus*. With respect to the caudal vertebræ, we find their transverse processes narrow and long, while the chevron bones, coössified with their centra beneath, are simply bifid, and the spreading part of the pygostyle, comparatively speaking, is not as large as usual. Finally, the neural spines of the dorsal series of vertebræ are very low, and the ends of their superior borders interlock both in front and behind.

Some very noted differences are to be seen in this part of the trunk skeleton when we come to compare *M. torquatus* and *M. carolinus*. First, in the last-mentioned species the post- and pre-zygapophyses of the mid-cervical vertebræ are not nearly so slender nor divergent; it has but five free caudal vertebræ,¹ and a large submarginal foramen pierces the pygostyle below.

There are also other minor differences which are to be recognized upon careful comparison. Right here I wish to point out a difference that exists in the axis vertebra of the Pileated Woodpecker and the same bone in *Dryobates*, *M. torquatus* and *M. carolinus*. In the first this segment of the spine is pierced upon either side by the vertebrarterial canal, while in the last-mentioned species the vertebral artery and vein skip this vertebra and pass directly from the canal in the third cervical to the corresponding canal in the atlas.

Melanerpes uropygialis exhibits some characters in its vertebræ and ribs that agree with the corresponding ones in *M. torquatus*, while others agree with *M. carolinus*. For instance, it has six free caudal vertebræ and the pygostyle, the latter showing the

¹ Determined from two specimens sent me by Dr. Strode.

medio-submarginal foramen. One peculiar character is seen in this handsome Woodpecker, and it is in the first or anterior pair of its dorsal ribs. Here the epipleural appendages, the one on either side, fuse with the margin of the rib for the entire length of its superior border. In other words, the epipleural appendage is parallel with its rib, its upper margin being coössified with the posterior or adjacent border of the rib to which it belongs.

None of the species of the genus *Sphyrapicus* seem to present us with any very marked departures from what I have attempted to give above in reference to their spinal column and ribs. They have *six* free caudal vertebræ, the fenestra exists in the pygostyle, the atlas is perforated for the passage of the vertebral vessels on either side, and the ribs seem to be slenderer than is usual among Woodpeckers.

In this genus, in *M. carolinus* and no doubt in some others, the lower ends of the last pair, or "floating costal ribs," coössify with the hinder margin of the costal rib in front of them. This is not the case in *Dryobates*, *Picoides*, nor in some others; it may occasionally be seen in the Pileated Woodpecker.

Let us next consider the sternum in some of the *Pici*. Several characters of this bone are held in common by all the representatives of the group. It is always found to be highly pneumatic, with the foramina between the facets on the costal borders; secondly, on the thoracic aspect (1) down the median line, (2) transversely within the anterior border, and (3) a large median one at the base of the manubrium. The carina is comparatively shallow, and notably extended forward beyond the body of the bone. Either costal process is lofty, pointed, with all the facets for the costal ribs arrayed down its posterior border. In front, a more or less bifurcated manubrium is seen. Behind, the body of the bone is expanded, and profoundly two-notched upon either side, thus giving the xiphoidal processes dilated posterior ends.¹

The costal grooves are prominent, separated mesially, and a small subcircular facet is found at the termination of either one of them externally. They are for articulation with the coracoids.

¹ In the sternum of a specimen of *Colaptes mexicanus* at my hand the inner notch of the left pair is a large subelliptical foramen, caused by the fusion of the inner tip of the process with the outer tip of the adjacent angle of the body of the bone.

In *Colaptes* the manubrium is strongly bifid, pneumatic foramina occur at all the points mentioned above, the notches of the hinder part of the body are profound, and the anterior border of the carina is convexed forward. In *Campephilus* the manubrium is small and feebly bifid, and there is no median pneumatic foramen posterior to its base; the articular borders of the costal processes are very broad transversely; the body of the bone is much expanded posteriorly, though the "notching" is comparatively shallow; the anterior carinal border is irregularly scalloped.

In the Pileated Woodpecker we find a sternum closely resembling the bone in *Campephilus*; in it, however, the notches are comparatively deeper, the bifurcation of the manubrium more evident, and the carina comparatively deeper. This notching of the xiphoidal margin of the sternum though is found to vary with respect to its profundity in different individuals of the two last-mentioned genera.

Dryobates has a typically picine sternum, with a bifid manubrium, and the anterior border of the carina nearly straight and vertical—a condition that is likewise present in the bone in *Xenopicus*.

Picoides arcticus exhibits nearly the same characters with the last two, but in it we find a sternum that calls to mind the bone as it occurs in some of the *Passeres*. The carina is deeper and not so prominently brought forward in front. Four notches behind, however, dispel the resemblance.

Changing pattern again in *Melanerpes torquatus*, we find a sternum with a shallow keel, with a conspicuously produced fore part; a subaborted bifid manubrium; a shortish body, with thin costal processes; and, finally, the bone less pneumatic than is the rule among Woodpeckers. Some of these features are carried still farther in *M. carolinus*, where pneumaticity of the bone is at its minimum, and the bifurcations of the minute manubrium are almost or quite aborted. In this species, however, the xiphoidal processes are slender, and the notches that create them more than usually deep. All this agrees very well with what we find in *M. uropygialis*, but in the sternum of this bird the carina again is very shallow and the "notches" not strikingly deep—at least not nearly as much so as they are in *M. carolinus*.

Other species of this genus show some slight individual peculiarities in their sterna that, taken in connection with other characters, ought to some day assist in determining affinities.

In *Sphyrapicus* the xiphoidal processes are uncommonly slender; the body of the bone thin and delicate;¹ while the horns of the manubrium are a little larger again.

All of our species of Woodpeckers possess an os humero-scapulare at either shoulder-joint. It has much the same form and relative size as we find it in birds of comparative proportions among the Passeres. With respect to the several bones of the shoulder-girdle, however, they are seen to have quite dissimilar patterns among the *Pici*, although the general plan or form is the same. Most curious do we find a scapula to be in *Colaptes*. It is fashioned like a flattened great J, with the curved portion enlarged and directed outward. Either coracoid has a long, slender shaft, with the head of the bone much produced upward, and compressed from side to side. At its sternal extremity we find a sharp, thin, hook-like process at its outer aspect, with two concave, transverse facets below, and a small subcircular one at its suprainfero-mesial angle. As we know, these facets are for articulation with the sternum. The glenoid facet at the other end of the bone is long and narrow, and is inclined to be convex outward rather than a "cavity," as it really is on the scapula. Os furcula is of the typical U-shaped pattern, with enlarged, triangular, transversely compressed heads, and no hypocleidium below. The clavicular limbs are delicately constructed, and likewise compressed in the transverse direction. All the bones, with perhaps the exception of the furculum, of this arch are highly pneumatic, and when articulated *in situ* the great, flattened, subtriangular head of the furculum on either side is lain flat against the scapula and coracoid, which in turn are articulated in the usual manner.

Adult Ivory-billed Woodpeckers possess a strong pectoral arch, and in this species all of the bones composing it are thoroughly pneumatic. Relatively they are considerably shorter than the corresponding bones in a *Colaptes*, with their extremities somewhat stouter. The scapula does not especially remind us of a J, although its posterior end is abruptly turned outward, but it is about at right angles with the shaft and not enlarged or curved any. Proportionately speaking, the coracoidal end of a scapula in this

¹ I have one specimen that shows a normal circular fenestra in it on the right side, just anterior to the inner notch, and probably this character will be found in a certain percentage of the sterna of this species, *S. v. nuchalis*, as well as others of the genus.

species is tuberosus and the pneumatic foramina upon its anterior face large. A coracoid lends but a limited share of the articular surface for the head of the humerus, but a large, subtriangular facet is seen upon the scapula for that purpose.

In *Melanerpes torquatus* the same general characters as we have described obtain, but, as we would naturally expect, the several elements of the arch possess a peculiar facies of their own. A blade of a scapula, for instance, is vertically compressed, while its enlarged posterior end is not nearly so abruptly turned outward as it is in *Colaptes*. At the lower outer angle of the sternal end of a coracoid, the process is handsomely developed and the facets below very distinctly defined. This last description agrees pretty well, too, with what we find in *M. carolinus*, though good differences exist in minor details. *Dryobates villosus* has the posterior end of either scapula bent out at a right angle with the shaft, which is also the case in *Xenopicus*, while in *Ceophlæus* all the bones of the arch are fashioned more as we find them in *Campephilus*.

Various species of *Sphyrapicus* show all the picine characters of the bones of the shoulder-girdle, and in them the hinder ends of the scapulæ are enlarged and stand at a right angle, in either case, with the shaft.

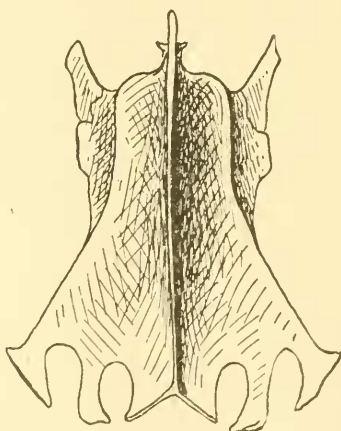
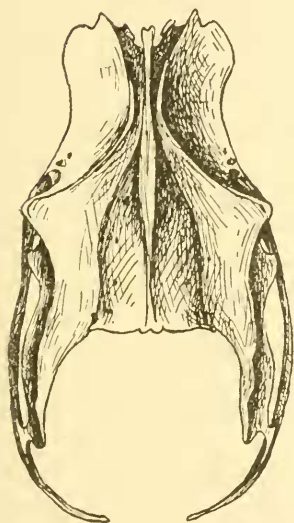
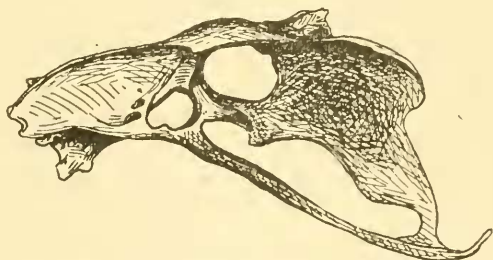
Very conspicuous indeed is the process at the outer aspect of the sternal end of a coracoid, it being sharp-pointed and somewhat turned backward.

In some Woodpeckers, as the Ivory-bill, this last character would hardly attract especial attention. It is but moderately marked in *Picoides*, a bird which also has a typical picine pectoral arch.

Any American Woodpecker is always possessed of a large, capacious pelvis, and in *Colaptes*, when we come to view the bone from above, it is seen to have a moderately extensive pre-acetabular region, with a much larger post-acetabular one. An ilium is pointed in front, and these bones diverge from each other as they proceed forward. This creates a canal of increasing size on either side of the prominent crista. Posteriorly the "sacrum" fuses completely with the ilia and presents behind more or fewer small parial, interdiaphysial foramina.

At the side, the antitrochanter is small, though prominent; the ischiadic foramen of good size; a large obturator space merging with the small subcircular obturator foramen; a circular acetabulum with its base entirely absorbed. There is no propubis, and

the postpubic bone is long and slender, being produced well beyond the ilia on either side behind. Sometimes it fuses with the foot-like process sent down by the ischium. Superiorly the hinder margin of the ischium is roundly concaved, the lower part being convexed outward. Upon the aspect now under consideration we see that the pelvis is rather deep. This feature is very characteristic of such a form as the Ivory-billed Woodpecker (see Fig. 8).



STERNUM AND PELVIS OF IVORY-BILLED WOODPECKER,
(*Campephilus principalis*.)

FIG. 8. (Upper one.) Left lateral view of the pelvis.

FIG. 9. (Left-hand one.) Superior view of the same bone.

FIG. 10. (Right-hand one). Anterior aspect of sternum.

All figures life size from nature by the author from specimen No. 18578 of the collections in the United States National Museum.

The calibre of the neural canal is subcircular and not large, and swells but little for the enlargement of the myelon where the sacral plexus is given off. One thing strikes us as peculiar in this pelvis, and that is upon its ventral aspect there is no lengthening nor any other change in the transverse processes of the vertebræ opposite the acetabulæ. It is well known that in a great many birds these are increased in size and strength and thrown out as buttresses against the ilia as a means of support for these points, they being opposite the articulation of either femur. Anteriorly there are three vertebræ that throw out their diapophyses against the ilium on either hand.

In *Dryobates* the general character of the pelvis is the same, presenting but few specific differences. Viewed from above there is seen to be a flush, smooth and level area mesially situated between the points where the "ilio-sacral canals" terminate behind and a pair of triangular depressions over the sacrum posteriorly for the lodgment of caudal muscles. This is also fairly well marked in *Colaptes*. In *Xenopicus* the pelvis is very much like that bone in *Dryobates*, while in *Picooides arcticus* it has a pattern peculiarly its own. Here the pelvis is short antero-posteriorly, with very deep sides, and post-pubic elements scarcely produced at all behind. Moreover, in *Picooides* the obturator space is shut off by bone from the large subcircular obturator foramen, and the downward projecting process of either ischium behind is exceedingly small.

The pelvis of *Melanerpes torquatus* reminds me very much of the pelvis in *Colaptes*, it having the same general character and form. The same remark applies, though not so strictly, to the bone as we find it in *M. carolinus*.

In the Ivory-billed and Pileated Woodpeckers the pelvis much resemble each other, but in the first-mentioned species the side of the bone posterior to the acetabulum is comparatively much deeper, while in the Pileated Woodpecker the descending foot of the ischium is relatively much broader and always fuses with the superior edge of the post-pubis where it meets it. In both these species the pelvis is largely pneumatic, a condition that obtains to a greater or less degree for this bone in all of our *Pici*; least so, perhaps, in such a type as *Sphyrapicus*. *Sphyrapicus v. nuchalis* has a pelvis quite picine in all its characters. Some good distinctive features present themselves when we come to compare such a pelvis with the pelvis of *Tyrannus tyrannus*.

In the Tyrant Flycatcher to which I allude (1) the parial foramina of the post-acetabular region are present and large. They are absent in the Woodpecker. (2) In *Tyrannus* the descending process of the ischium is slender and nearly straight; its foot does not coössify with the post-pubis. (3) The Tyrant Flycatcher has the obturate space and foramen separated by a delicate bridge of bone. They merge into one fenestra in the Woodpecker. (4) *Tyrannus*, on the ventral aspect of the basin of the pelvis, opposite the acetabulæ, has the transverse pleur- and diapophyses thrown out as abutments against the ilium, upon either side, as tie-beams. No modification of the parts mentioned is to be seen in *Sphyrapicus*. (5) *Tyrannus* has its ilio-neural canals open behind upon either side of the sacral crista. They are closed at those points in the Woodpecker.

Before passing to the consideration of the appendicular skeleton it will be as well to add here that I have glanced at the ossifications that occur in the *trachea* of *Colaptes*, and it will be seen that both the rings and the semirings are thoroughly ossified. At the upper extremity we find the usual bony thyroid plate, also arytenoid bones of a peculiar form. Each one develops two bifurcating limbs behind, which gently curve toward each other, and thus enclose or nearly enclose a subelliptical fenestra. Their free ends articulate with the corresponding side of the median bone at its upper tip. At the syringeal end of the trachea we find an ossified pessulus, with the ossified semirings below it. The form of the tracheal rings seems to correspond with the corresponding structures as we find them in most all ordinary birds.

OF THE APPENDICULAR SKELETON IN THE NORTH AMERICAN PICI.

So far as the pectoral limb is concerned, I may say I have examined it and compared it in some nineteen or twenty species of our Woodpeckers, and find that although there are some few distinctive characters, these appear for the most part to be slight, and in such a work as the present one need hardly be dwelt upon in detail. Pneumaticity, however, seems to differ among them in so far as its extent goes, for in *Colaptes* I find humerus, radius and ulna all pneumatic, while in *Melanerpes torquatus* only the first-mentioned bone enjoys that condition.

Ceophlæus pileatus offers us a very good average species wherein to study the characters presented on the part of this limb, and it

will be made to stand here for the group in this matter. An adult specimen of this form has a humerus measuring 5.4 cms. in length, an ulna of 6.5 cms., radius of 5.8 cms., and a total length of the skeleton of manus 5.1 cms.—a very well-proportioned limb.

Owing to its large pneumatic cavity, the humerus is very light, while, on the other hand, its shaft is large round. It exhibits the usual sigmoid curve, and the extremities of the bone are considerably expanded. The radial crest is long and rather prominent, and the ulnar tuberosity well over-arches the pneumatic fossa. At the base of the fossa the air-holes are very fine, and form a diffuse group of apertures leading into the humeral shaft. Between the ulnar tuberosity and the head of the bone a deep, oblique groove exists.

At the distal extremity the radial and oblique tubercles occupy their most usual positions, there being quite a prominent tuberosity on the radial border of the shaft immediately above the latter, and a still more conspicuous process produced distally below the former from the ulnar border of the bone.

The radius is nearly straight and slender; its shaft is quite uniform in calibre throughout. Its extremities exhibit the usual ornithic characters.

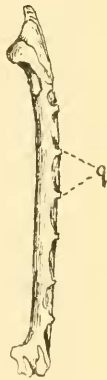


FIG. 11. Left ulna of *Colaptes mexicanus*, natural size, drawn by the author from a specimen in his own collection. *q* directs attention to the elevated osseous papillæ on the shaft for the insertion of the ends of the quills of the secondary feathers.

Nothing especial characterizes the ulna of the Pileated Woodpecker beyond the remarkable row of elevated papillæ down the

subpalmar aspect of its shaft. There are seven of these, and appear upon this bone in all of our *Pici*. Beyond this the ulna is seen to be a stout bone with subcylindrical shaft, the latter being nearly straight for its distal moiety—curved along its proximal half.

The olecranon process is well produced and all the articular facets and trochleæ of this bone are of good size.

A single sesamoid of no great size is found at the elbow, and in the adult Woodpecker the carpus is composed of the usual two free bonelets, the ulnare and the radiale. These latter possess each the form they are seen to have in most all ordinary birds, and their articulations also correspond.

The carpo-metacarpal bone of the hand has a few characters that should be noticed. Among these we observe that the articulatory facet or trochlea formed by the os magnum is, upon the anconal side, brought well down upon the shaft. Its border is rather thin-edged, and on the whole this part is compressed from side to side. Below the head of the bone there is seen a thin, laminated process coming off from the posterior aspect of the index metacarpal that laps flat over against the upper third of the shaft of the mid- or smaller metacarpal at its outer aspect. Such a process we will also find in this bone among the *Gallinæ*, *Passeres* and other groups.

The lower end of the midmetacarpal extends considerably below that end of the larger or index metacarpal, a state of affairs that is reversed in some birds, as in the *Trochili*.

Both pollex and distal index phalanges are comparatively small and pointed. They are without claws. The large proximal phalanx of the index digit is peculiar in that its posterior blade-like part is much reduced, and it is only distally that this part is produced a little, curves upward and meets the lower extremity of the small free phalanx of the middle or last finger. This last-mentioned phalanx is, contrary to the rule in ordinary birds, larger than either the pollex digit or the distal one of index, and is distinguished by having a tubercle projecting from the posterior aspect of the proximal third of its shaft.

Passing now to the consideration of the pelvic limb of the Pileated Woodpecker, the species in hand, we find that in the adult the femur measures 4 cms. in length, the tibio tarsus 5.4 cms., the tarso-metatarsus 3.7 cms., and the longest or outer

anterior toe 3.6 cms. The fibula rarely exceeds 3 cms. in length.

Besides the rather small patella, there are found one or more minute sesamoids in the tendons of the muscles that attach to the lower end of the femur, especially in that tendon which inserts itself between the femoral condyles (flexor longus hallucis). In it one appears to be constant.

Always pneumatic, the femur is characterized by a large air-hole situated at the usual site, when it occurs in this bone in *Aves*. A very shallow excavation for the ligamentum teres is found upon the femoral head, and the trochanter is not elevated above the articular surface at the summit of the shaft. This latter is nearly straight, subcylindrical on midsection, and is scarred by the usual muscular lines. As to the condyles, they are not large, and they offer us only the usual ornithic characters; the external one, being the lower, is grooved behind for the head of the fibula and has a small pit-like depression immediately above it. The popliteal fossa is shallow, as is also the rotular channel in front.

Tibio-tarsus possesses a large head, which is compressed antero-posteriorly, spread transversely, and is further characterized by having the cnemial crest well raised above the summit of the bone, while both pro- and ectocnemial processes are quite aborted or very nearly so. From end to end the shaft is slightly bowed outward or toward the fibula side. A line down its front is, however, practically straight. What appears to represent the "procnemial ridge" is here a thin crest passing down the upper half of the shaft upon its inner aspect. Directly upon the opposite side of the bone is seen the "fibular ridge," which is low proximally, and gradually increases in height to its termination below. This form of the ridge has the effect of keeping the distal end of the somewhat feeble fibula well away from the tibio-tarsal shaft. And it is about opposite the midpoint of this latter that we see the free pointed end of the fibula as it is held in that position.

Returning to the tibio-tarsus, we have still to observe that the usual osseous bridgelet crosses the tendinal canal at the antero-distal aspect, and that a tubercle is found above it upon either side, the outer one being the lower upon the shaft. The condyles are large, nearly of equal size, directly opposite each other

and separated in front, below and behind by a deep intercondylar notch. A pit is seen in the middle of this, below, for a conspicuous process standing up on the summit of the tarso-metatarsus.

Antero-posteriorly the articular facet on the summit of the fibula is concave. Just now I invited attention to the erect process standing between the concave articular facets upon the summit of the tarso-metatarsus in the Pileated and other Woodpeckers. This bone of the leg shows further that its hypotarsus is bulky, being both deeply grooved and perforated for the passage of the tendons. Its shaft is straight, rather small comparatively, and only slightly grooved down its length in front and not so at all behind. Distally the trochleæ are large and prominent, and among our *Pici* we find two patterns of these, one being as they occur in *Ceophlæus*, now in hand, and the other as they occur in the three-toed forms, such as *Picooides*. They differ, however, but very little, as the difference in *Picooides* is a suppression of the first toe and the small, free first metatarsal. Evidently this does not affect the form of the trochleæ of the tarso-metatarsus to any extent.

Turning to the Pileated Woodpecker again, we find a very interesting state of affairs, for the trochlea for the inside anterior toe is single and much compressed lateralwise; the one for the outer anterior toe is double, or, in other words, has two condyles with the median valley running round between them. Then comes the single trochlea again for the fourth toe or the outside hinder one. It is turned to the rear and articulates with the basal joint of the reversed toe. Posterior to this is a very large, irregular, freely-projecting trochlea, which articulates with a sesamoid at the back of the foot. This sesamoid is moulded on to the inner side of the base of the basal joint of the reversed toe and to some slight extent on to the base of the basal joint of the hind toe proper. Indeed it stands between them, and the trochlea intended for it is fully three times as large as the one for the fourth or reversed toe.

The accessory metatarsal is comparatively very small and freely suspended as usual. Considerable feebleness seems to characterize the true hind toe of the Woodpecker under consideration. Its basal joint is much compressed from side to side, and indeed this is the case with all these joints of the podal digits, it being especially noticeable in the first and second toes. The osseous claw to the first toe is also comparatively small, but the outer

three ungual joints are powerfully developed. So far as the number of joints is concerned they range as in the *Passeres*, normally—*i. e.*, two, three, four and five for first, second, third and fourth digits respectively—the anterior toes having three (inner) and four (outer) joints devoted to them, while the posterior ones have two (inner) and five (outer), thus showing the reversed toe to be the fourth of the typical avian pes.

SUMMARY OF THE CHIEF OSTEOLOGICAL CHARACTERS OF THE NORTH AMERICAN PICI.

1. Large but simple-scrolled turbinals; there may be a free turbinal.
2. Bulging of the frontal region over the transverse cranio-facial line may (*Picoides*) or may not (*Colaptes*) exist.
3. Generally the external cranial vault is more or less dented by the ends of the quills of the capital feathers.
4. The interorbital septum is sometimes entire and sometimes shows a fenestra.
5. Pars plana large, and often the os uncinatum is well developed.
6. Lacrymal usually vestigial in character.
7. Quadrato-jugal aborted.
8. Tympanic bullæ cowrie-shell-shaped and otherwise peculiar.
9. A large spur on the upper side of either pterygoid for muscular attachment.
10. A median, dagger-shaped vomer sometimes present, but sometimes absent.
11. Maxillo-palatines rounded lamina and very much aborted.
12. A more or less imperfect nasal septum usually present.
13. Vestigial basipterygoidal processes are distinctly developed in some species.
14. As ossification advances in the palatines it may be characterized as being "ragged" along the antero-mesial and antero-external margins of these bones. This often leaves little osseous islets not absorbed, a few of which may persist here and there throughout the life of the individual.
15. Either palatine is characterized by possessing an "interpalatine spine," or process, and this may be continued forward to fuse with the mesial border of the bone by its free tip. Either palatine also possesses a palatine spur springing from the anterior point

of the internal lamina of the bone, and being directed forward. It may also in some species pass on to fuse with the mesial edge of the palatine to which it belongs by its free end. The postero-external angle of a palatine is either truncated or shows various degrees of being bluntly rounded.

16. The mesopterygoidal process of a pterygoid is not paddle-shaped, but long and narrowly pointed.

17. Distinct orbito-sphenoids exist in the nestling.

18. Mandible very strong, typically V-shaped in pattern; sides deep; symphysis varies in depth; ramal vacuity absent, or minute if present, and never large. Posterior angular processes more or less truncated; internal angular processes large. In some species the posterior third of the inferior ramal border somewhat tumefied and roughened.

19. Rudimentary cerato-hyals which early fuse together.

20. Uro-hyal absent.

21. Elongated thyro-hyal elements curl up over the cranium to a greater or less extent. They may pass round the right orbit. They may come to the posterior margin of the right external narial aperture. They may hardly come up on the cranium at all. Whenever they do the cranium is usually externally furrowed to receive them.

22. Sclerotal plates of the eye commonly fuse completely together around their external periphery and toward the centre.

23. "Double 'infrastapedial' and ossified stylohyal" (Parker).

24. Rings, semirings and other parts of the trachea ossify.

25. There are nineteen free vertebræ between the skull and pelvis; the vertebrarterial canals pierce the atlas and in some species the axis; the atlantal cup is perforate; there are no parial parapophyses; the carotid canal may or may not be entirely closed in by bone; where they are present the neural and hæmal spines are usually very large. There are three pairs of cervical ribs, five pairs of dorsal ribs and one pair of sacral ribs. The hæmapophyses of the latter do not reach the sternum. In some species the first pair of costal ribs are very robust, as are the last pair of cervical ones. There are five or usually six tail vertebræ (free), with an enormous pygostyle. Most of these parts are highly pneumatic.

26. The sternum is two-notched on either side of the carina; the manubrium is either slightly or very much bifurcated; the costal

processes are long and pointed, and the keel is usually rather shallow, projecting forward and carried up under the manubrial process. The sternum is usually quite completely pneumatic.

27. In the pelvis we find the ilia gradually diverging from the sacral crista as they pass forward. Parial interdiapophysial foramina are either very minute or entirely absent. Ischial notch on the posterior margin of the bone long, rounded and shallow. Acetabulæ large, and bases completely absorbed. Sides of pelvis usually very deep. Postpubic slender, extends beyond ischium, the foot of which latter may or may not fuse with it. Obturator space large, and may or may not merge with the obturator foramen. *Three* of the vertebræ of the sacrum anteriorly throw out their processes against the ventral iliac walls. The pleurapophysial and transverse processes of the sacral vertebræ opposite the acetabulæ are not modified and lengthened so as to act as braces at the points in question. The pelvis is commonly completely pneumatic.

28. Bones of the shoulder-girdle pneumatic, with sometimes the exception of the os furcula. This latter is of the U-shaped pattern, without hypocleidium; large, flat, scapulo-coracoidal ends (which originate from separate ossific centres in the young), and with laterally compressed limbs. Posterior end of scapula more or less modified to be bent or to curl outward, giving the bone a very unique form. Coracoids long, not very stout, and with the anterior end more or less laterally compressed.

29. An os humero-scapulare present at either shoulder-joint; functional, and has much the same shape as the ossicle has in the *Passeres*.

30. Either the humerus alone, or it together with the long bones of the antitrachium, may be pneumatic. A small sesamoid is found at the elbow. Seven prominent osseous papillæ occur, at nearly equal distances apart, down the shaft of the ulna. The flat, rounded process from the postero-upper third of the shaft of index metacarpal is present. The slender last metacarpal extends below the one of index, and its free digital joint is *larger* than either of the other terminal phalanges. The proximal phalanx of index digit has its posterior blade almost entirely aborted. There are no claws.

31. Femur is always pneumatic, and so may be the tibio-tarsus in some species. In the former, trochanter major does not rise above the summit of the shaft; the excavation on the head is very